A STUDY OF MT KOROROIT, VICTORIA—A SMALL VOLCANIC VENT

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Abstract: A geological reconnaissance and gravity survey indicate that Mt Kororoit is composed mainly of scoriaceous material and began to grow in the early stage of formation of the surrounding lava sheet.

REGIONAL GEOLOGY

Mt Kororoit (also known as Mt Misery, at 37°39'S, 144°40'E) is a small conical hill about 1500 m in diameter at the base, rising about 100 m above the surrounding countryside. It is one of many flat-topped volcanic cones on the Werribee Plains, which lie on the northern and western outskirts of Melbourne. The plains consist mainly of sheets of basaltic lavas, dotted with vents, of the Pliocene to Pleistocene Newer Volcanics. The lavas lie unconformably on folded Palaeozoic (mainly geosynclinal) sediments, which protrude through the basalt in a number of places, especially to the northwest of the plains. Deposition of these sediments ceased in the Middle Devonian, and was followed by a period of granite intrusion during the Upper Devonian. Sedimentation resumed in the Cainozoic; in adjacent areas it continued during the Lower Carboniferous, Permian and Mesozoic (Vandenberg *et al.* 1973).

GEOLOGY OF MT KOROROIT

Although occasionally noted in the literature on Victorian volcanoes, we believe that Mt Kororoit has not previously been studied in any detail. A geological map of the volcano based on aerial photograph interpretation with some field work is presented in Figure 1. Basically, the hill appears to be a scoria pile elongated somewhat to the west, with a minor change of slope probably marking the edge of the scoria. Cultivation of the surrounding area has made the background difficult to define.

Shallow pits have been dug in the scoria on the northwest flank of the mountain. These expose some vesicular lava containing small feldspar phenocrysts and pieces of fresh scoria. Outcrops of unweathered rock show the scoria to consist of small irregular lapilli welded together with spatter material. Small scale flow features can often be recognised in the spatter.

Four features are prominent on the aerial photographs:

(a) The resistant capping on the summit of the mountain.
(b) Two thin ridges which trend northeast and southeast from the cap.
(c) A series of concentric arcuate structures on the northwestern side of the northeast ridge.
(d) A series of arcuate structures about 1 km northwest of the cap.

Close investigation in the field shows that the cap rock consists largely of agglomeratic material, although basalt is found in some places. Three almost concentric tiers form the cap, the upper showing consistent dips of about 40° towards the centre of the cap, while the third and lowest has a much gentler dip. Some thin layering is also present in the cap outcrop, being aligned parallel to the dip.

A large number of volcanoes in the Gisborne district show the distinct flat-topped basalt capping. It has been suggested by Edwards and Crawford (1940) that the cappings represent basaltic crater infillings later exposed by the erosion of the scoria crater walls which once confined the lava. Some of these volcanoes also show evidence of the crater having been breached, resulting in a lava flow forming what is now the gentlest slope. This is not as strongly evident at Mt Kororoit.

Another possibility is that the basalt cap is more than just a crater infilling, and is in fact the top of the former lava conduit.

Originating at the cap rock and striking radially, the highly vesicular basalt ridges have been variously described as radial dykes (Singleton 1973) and as a fine example of radial squeeze-ups (Vandenberg *et al.* 1973). These seem similar in composition to the summit capping.

Within the outcrop, one can recognise flow patterns lying sub-parallel and parallel to the dip of the outcrop. It is most noticeable where one finds thin elongate vesicles aligned in curved patterns. Often, however, the vesicles are very fine or there are no vesicles present at all.

Along the northeastern ridge, one encounters dips to the southeast of between 20° and 70°. Dips along the southeastern ridge are generally about 30° to the northeast and east. The forks of the southeastern "dyke" extend in discontinuous outcrop further than was noted from aerial photographs. Between these forks lie a number of small outcrops of basalt, many of which are linear, sub-parallel to and dipping in the same direction as the nearby ridges.

The concentric arcs of rock to the northwest of the northeast ridge are very prominent on the aerial photogaphs, but are much more difficult to recognise on the ground. At this level they are not readily

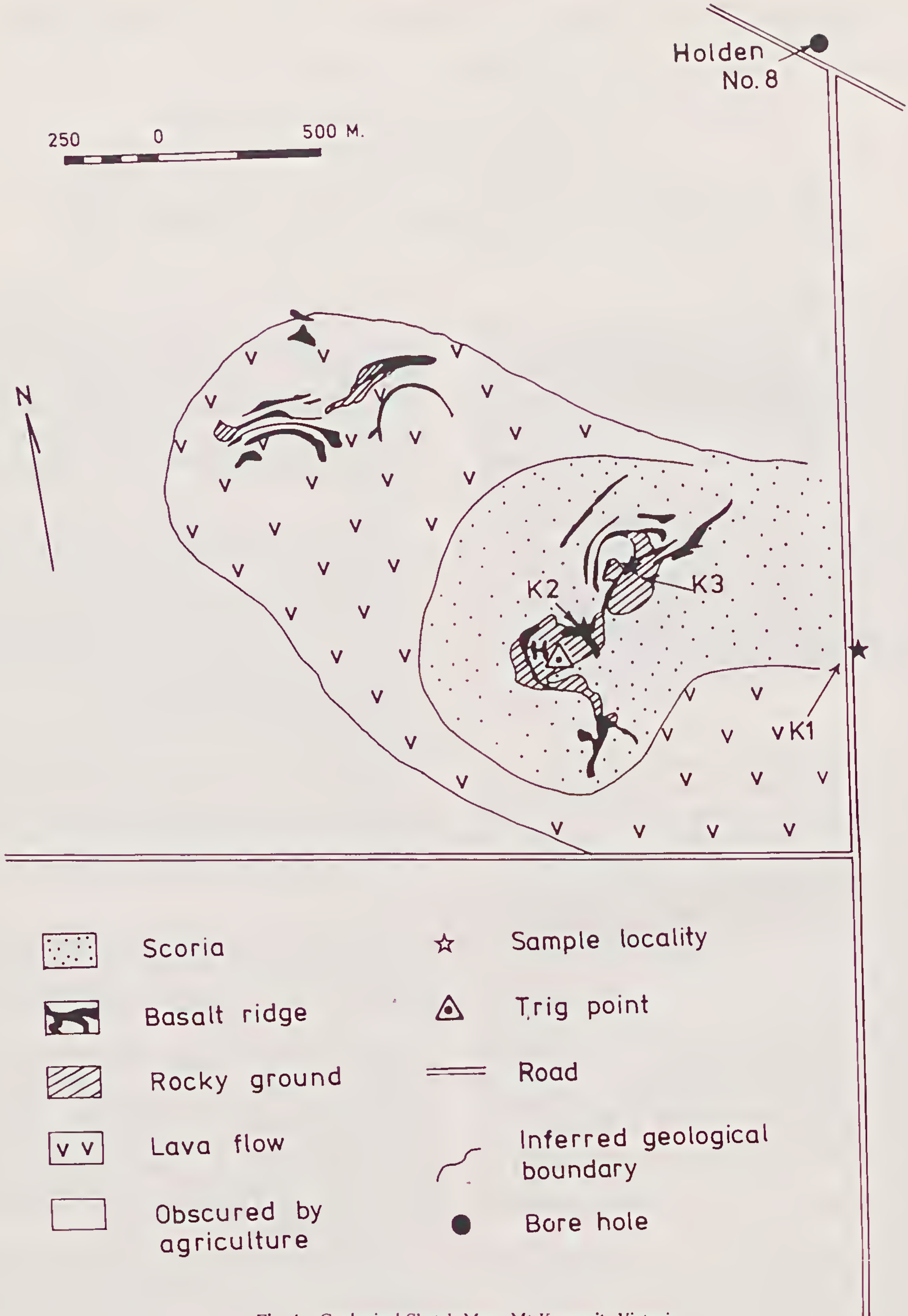

Fig. 1 – Geological Sketch Map, Mt Kororoit, Victoria.

distinguishable from other areas of rocky ground presumably weathered from the basaltic material.

The arcuate features northwest of the cap have flat tops and relatively steep fronts, and are probably either tumuli in, or lobes of, a lava flow extending in that direction.

Samples were taken of the two major rock types for density determinations, and a brief description of these is given in Table 1.

TABLE 1

BRIEF DESCRIPTION OF ROCKS USED IN DENSITY MEASUREMENT

Rock Type	Description	Locality of Samples
Scoria	Red-brown colour, fairly well consolidated, fine vesicles showing some flattening; in part made of fine lapilli aggregates; some well preserved phenocrysts.	K1, road cutting about 1 km east of the cap.
Basalt	Medium to dark brown colour; vesicular basalt; very hard; fine to coarse gradation of vesicles-elongate, aligned and compressed; occasional vesicles filled with muddy material.	K2; edge of basalt cap. K3; northeast ridge.

GRAVITY SURVEY

The gravity survey at Mt Kororoit formed part of an undergraduate field exercise. Four major traverses, running approximately north, south, east and west were laid out from the trig marker on the summit. These lines extended at least 1 km from the summit. Additional lines were also laid out on the flanks of the hill to provide additional control on the anomaly shapes on the hill slopes. The average station spacing was 60 m; the lines are shown on Fig. 2.

Two gravity meters were used; Worden No. 169, loaned by the Bureau of Mineral Resources, and Scintrex No. 255-G. Both meters were calibrated immediately before the survey. All station elevations were determined by spirit levelling. Loop closure errors in both the gravity and levelling data were adjusted numerically after gross errors had been detected and removed.

DENSITIES

Density determinations were carried out on 45 rock samples collected from three localities in the field (Fig. 1). The results are given in Table 2. Although the two classes of sample were quite distinctive in appearance, their densities were similar; in fact they appear statistically to be drawn from the same population (Student's test; $p>0.95$). Accordingly, a weighted mean density of 1.66 $g.cm^{-3}$ was taken as the density of the hill material for Bouguer reduction purposes.

The indirect 'density profile' method of Nettleton (1976) was also used. The density indicated by this method was about 1.6 $g.cm^{-3}$ in good agreement with the sample results.

TABLE 2

SUMMARY OF WET BULK DENSITIES FOR THE ROCK TYPES SAMPLED

Rock Type: (Locality)	Mean Density ($g.cm^{-3}$)	S.D.	No. of Samples
Scoria: (K1)	1.63	0.09	20
Basalt: (K2) & (K3)	1.68	0.06	25

Weighted mean density of scoria and basalt = 1.66 $g.cm^{-3}$
Standard Deviation (S.D.) = 0.06

DATA REDUCTION

The gravity data were corrected for latitude, elevation and Bouguer plate effects, using the scoria density value (1.66 $g.cm^{-3}$) and a datum plane at the approximate level of the surrounding land (150 m above sea level). Terrain corrections were determined for isolated stations, but found to be negligible.

No regional gravity gradient was observed on the major traverses, so the Bouguer gravity values were arbitrarily adjusted before display by subtracting 45.62 mGal from each value. The resulting values were then three-point smoothed before plotting (Fig. 2).

The residual gravity contour map (Fig. 2) clearly shows a negative anomaly, with a maximum amplitude of 1.8 mGal. The anomaly is hour-glass shaped, with the long axis approximately north-south and the narrowest point just where the present volcanic cap appears.

INTERPRETATION

GRAVITY DATA

The form of the gravity anomaly, together with the surface features, suggests that a shallow subsurface depression filled with less dense material exists. The shape of the anomaly may reflect the shape of the depression, or variations of the density of the fill.

The near-surface rocks near Mt Kororoit are the Newer Volcanic lava flows, and in a nearby bore (Holden No. 8, see Fig. 1) a total of 74 m of flows were encountered overlying Silurian mudstones.

The form of the gravity anomaly around the two minima can be satisfied by assuming that the source is approximately 75 m in thickness, with its surface at the level of the surrounding terrain, and with a density contrast of approximately -0.9 $g.cm^{-3}$. If the material filling the depression is scoria similar to that sampled, then the bulk density of the basalt flows should be about 2.56 $g.cm^{-3}$, which is a reasonable value for such rocks. We therefore propose that the fundamental basin shape of the anomaly is due to the presence of an island of scoria in the basalt sheet.

The 'neck' of the anomaly coincides approximately (but not exactly) with the position of the prominent surface ridges to the northeast and southeast. The amplitude of this part of the anomaly (positive, with respect to the larger anomaly) is about 0.5 mGal, which could arise from a shallow sheet of more dense material (density equal to that of the surrounding lavas) of approximately 10 m thickness buried within the cone.

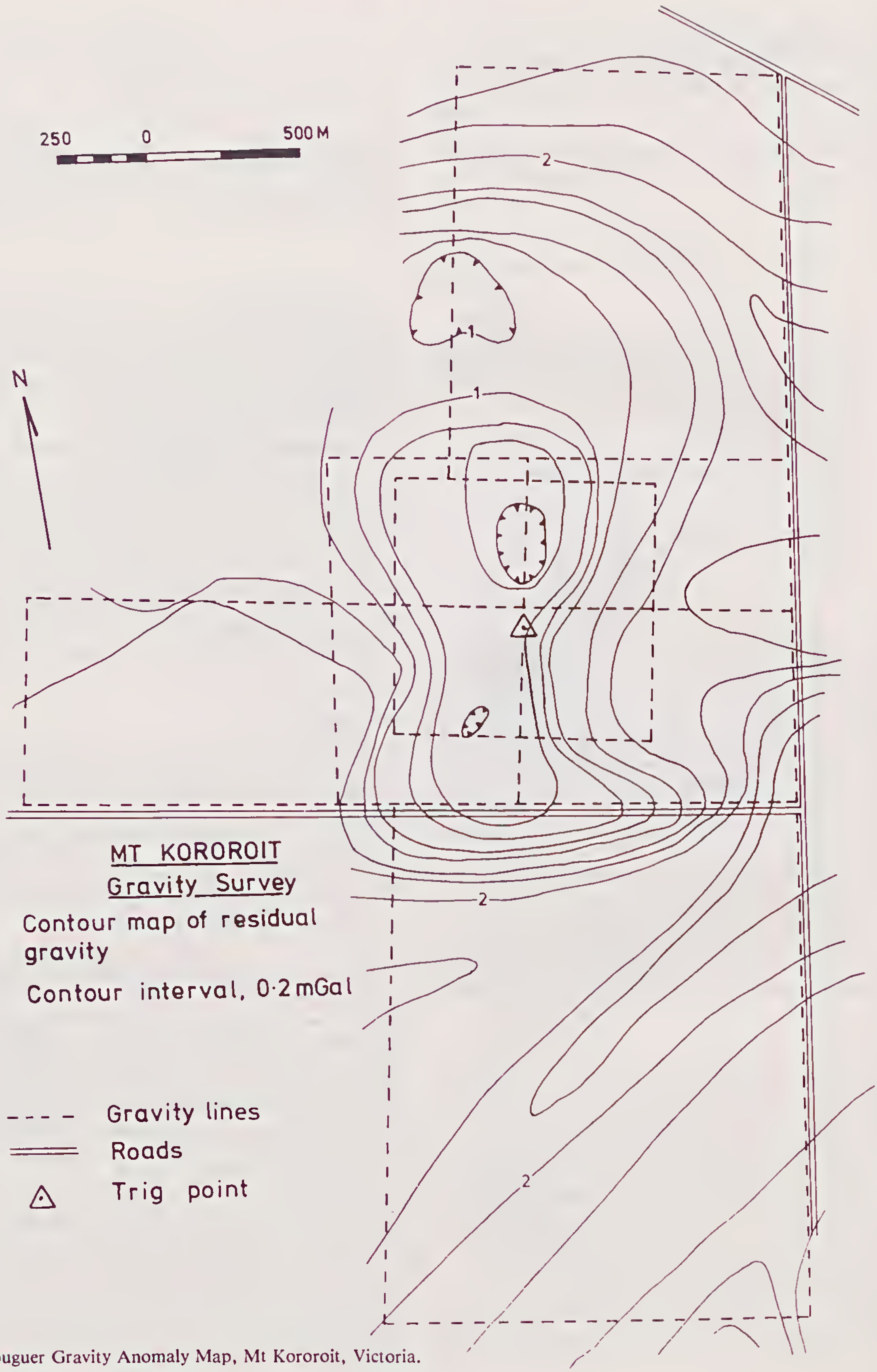

Fig. 2 — Bouguer Gravity Anomaly Map, Mt Kororoit, Victoria.

A more detailed interpretation of the gravity anomaly has been attempted, but is not very illuminating, as the details depend to a great extent on the interpreter's starting assumptions.

We modelled, for instance, a hypothetical feeder pipe below the cone as a vertical circular cylinder of radius 25 m with its top at 75 m below the datum plane. With a density contrast of $+0.4$ g.cm^{-3} such a column would give a circular gravity anomaly with a maximum value of 0.25 mGal and a half width of the order of 200 m. While such a component could be added to any model, we see no compelling evidence for a significant column of lava at the centre of the cone.

Combined Data

We propose the following sequence of events to explain the field and gravity data which we have reported. Eruption at Mt Kororoit began at an early stage in the development of the surrounding lava sheet, with effusion of mainly scoriaceous material forming an island in the lava. Periods during which more fluid material was erupted were interspersed, probably adding to the flows forming the sheet around the cone, and accounting for the lobes to the northwest of the cone. Discontinuities of eruption allowed the magma to withdraw in the narrow central vent, and so produce the inward dips in the tiers of lava remaining at the top of the cone.

Near the end of activity, lava flowed from the cone towards the east over a bed of scoria. The ridges northeast and southeast of the cap represent the edges of this flow, and dip inwards toward the flow as a result of subsidence while the flow was still plastic. The dips could also result from confinement in a channel of scoria now eroded. The rocks sampled at the ridge may be more vesicular than the body of the flow and so give the lower densities observed.

The final phase of eruption began with a burst of spatter (fire fountaining) which agglomerated to form the present cap rock, and ended with an eruption of scoria which blanketed the flanks of the cone.

Gases derived from beneath the flow may have formed the arcuate structures to the north of the northeast ridge, by a blistering process. Subsidence of the flow may have been aided by the weight of the scoria erupted in the final phase and which now covers the flow.

The topography suggests that the final flow must have occurred after most of the surrounding lavas were in place; however, subsequent erosion has most probably severely modified the external shape of the cone.

SUMMARY

Observations at Mt Kororoit indicate that the cone is composed of a pile of scoria, with basalt layers interspersed, which began to form during the early stages of the formation of the surrounding lava flows. Eruption must have continued, intermittently, for much of the period during which the flows were emplaced.

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